LESSON 25 DRAWING THE LEVER ESCAPEMENT

(cont'd)

Sections 435 - 442

CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

SEC. 435—Drawing the Pallets

We will now proceed to draw the pallets, transferring lines as are needed in making Plate 25-1.

In order that we may keep our finished drawings of uniform size, we will show only four teeth of the escape wheel in the following drawing. Consequently, some of the working lines will be located outside of the border lines and will serve no purpose on the finished drawing. If the student desires to make a larger drawing in order to show a full escape wheel, it is permissible and desirable.

Locate Center **B** 55 mm, below the border line.

Locate Center **C** 115 mm, above **B** on center line **A**.

Transfer lines **E, F, K, O, H, L, M, N.**

Transfer circles **J** and **P.**

Transfer arcs **G** and **Q.**

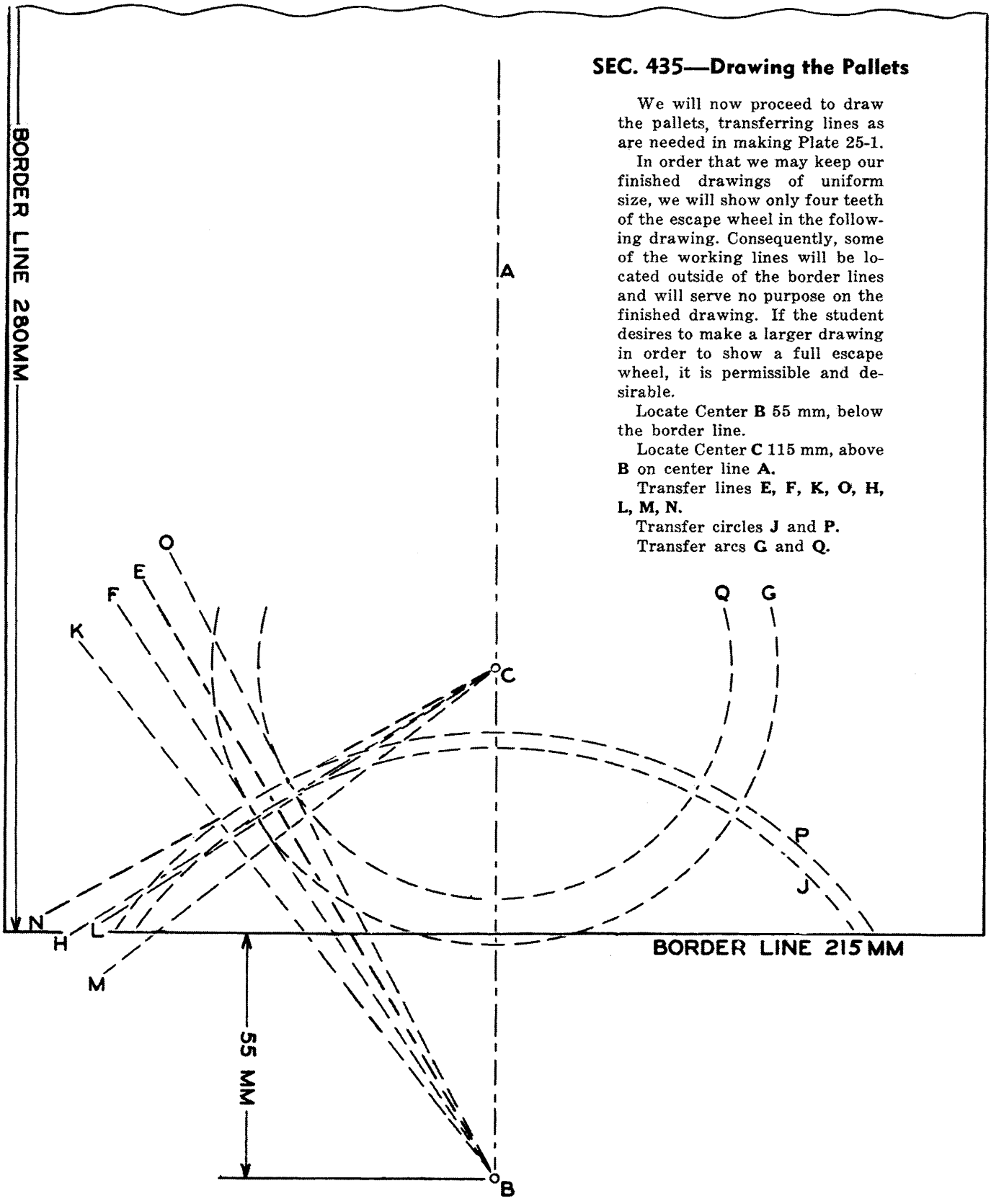

PLATE 25-1

SEC. 436—Circular Impulse and Lift

The circular impulse and lift combined must be the same on both the receiving and the discharging sides. The circular impulse of the teeth is always the same, regardless of the position of the wheel. The circular impulse of the stones and the lift of the teeth must be modified according to location. As has been stated, the lift must be the same on both sides, but the proportions between the lift of the wheel and that of the stone vary.

Extend arcs **G** and **Q.**

The points from which the circular impulse of the discharging stone is determined are the intersections of arc **Q** with circle **J** and of arc **G** with circle **P**; therefore, draw lines **1** and **2** from **B** through these points. These lines embrace an angle of 6 degrees, as do lines **F** and **O** on the receiving side, and are the circular impulses of the stone.

The lift of the tooth is determined on the discharging side from the same intersections; therefore, draw lines **3** and **4** from **C** through these points.

Compare the angle included between **H** and **N** with that between **3** and **4.**

The lift of the tooth at the discharging side is greater than at the receiving side. In order that the combined lift be alike on both sides, it follows that the lift of the stone must be less on the discharging side. At the discharging side the wheel lifts the pallets through an arc of 4½ degrees; the lifting angle of the discharging stone must be just enough to make up the difference between that amount and 8½ degrees, which is the entire lift. This amount will be 4 degrees.

From **C** draw line **5,** 4 degrees above line **4.**

Connect the two points of intersection: **Q** and **5** with **G** and **4.** This will give the impulse face of the discharging stone.

Connect the intersection of arc **G** with line **L** and arc **Q** with line **M.** This will give the impulse face of the receiving stone.

The student who desires to acquaint himself thoroughly with the principles involved in this type of escapement should carefully note the points referred to above. At the risk of repetition we will explain again.

The action of the escape wheel tooth in oscillating a pair of pallets drives them through an arc of a circle the angular extent of which is measured by radial lines from the pallet center. The angle formed by these lines is called the lift. The lift given in the drawing under consideration is 8½ degrees, exclusive of the lock —the lock being no part of the active impulse.

The lines that measure the lift of the pallets pass, one through the locking corner, the other through the releasing corner of each stone, the angles formed thereby being identical, regardless of the changing position of the pallet.

Radial lines from the pallet center also measure the lift of the wheel tooth. These lines pass, one through the locking corner, the other through the releasing corner of the wheel tooth. There is this difference, however, between the two conditions: The locking and releasing corners of the stones do not change their relation to the center from which the lift is measured, while the locking and releasing corners of the escape wheel teeth are constantly changing their relation to the center from which their lift is measured.

This being the case, the manner in which the lifting angle of a tooth is measured is to draw one line from the center of the pallets through the locking corner of an escape tooth at the point where the lift begins and another where the lift ends, the embraced angle being the lift of the wheel tooth.

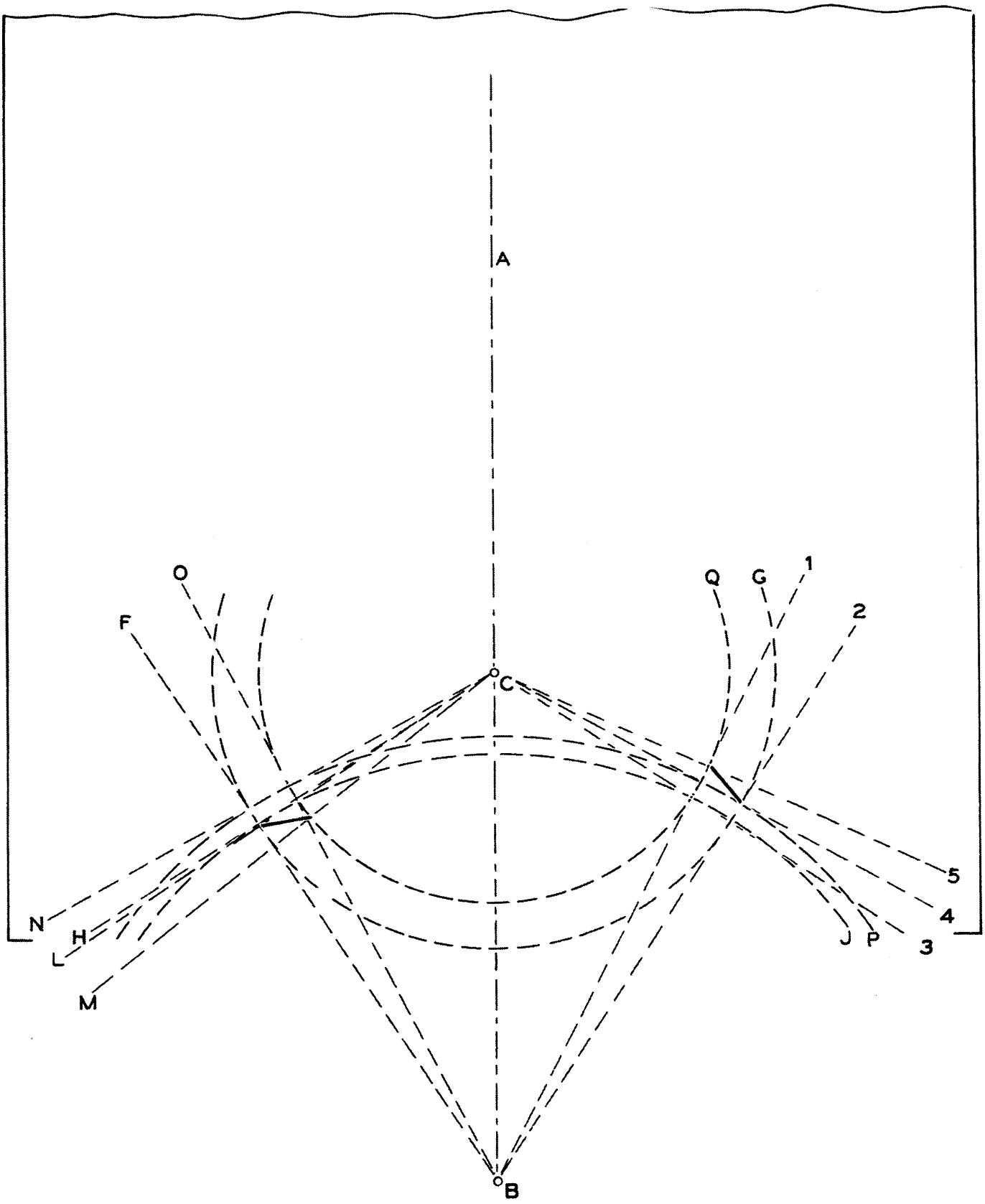

PLATE 25-2

SEC. 437—Angle at which Locking Faces Are Drawn

We will now determine the angle at which the locking faces of the stones should be drawn. They should be at such an inclination that the pressure of the wheel teeth will bring the fork to its bankings, holding it there until released by the action of the roller jewel. This is called the draft or draw. Its force is determined by the angle that the locking face forms with a line at right angles to a radial line from the pallet center to the locking corner of the stone. **L** is such a radial line, **6** is a line at right angle, and **7** is the line upon which the locking face of the stone should be drawn.

From the locking corner of the receiving stone draw line **6** at right angles with **L.** From the same point, draw line **7** at the right of, and **14** degrees from **6.** From the releasing corner draw line **8** parallel with **7.** This will give the form of the receiving stone.

Instead of drawing line **6** from which to take the angular measurement, it may be taken directly from line **L,** the angle being 76 degrees. The complement of an angle is the difference between that angle and **90** degrees. Now inasmuch as **6** forms an angle of 90 degrees with **L,** and we wish to draw a line 14 degrees less, if we draw it 76 degrees from **L** it will amount to the same thing.

From the locking corner of the discharging stone draw line **9** at right angles with **5.** From the same point, draw line **10** at the right of, and **14** degrees from **9.** From the releasing corner draw line **11** parallel with **10.** This will give the form of the discharging stone.

For our purpose, the length of the **R** stone measured from the locking corner will be **33** mm. The length of the **L** stone from locking corner is **34** mm.

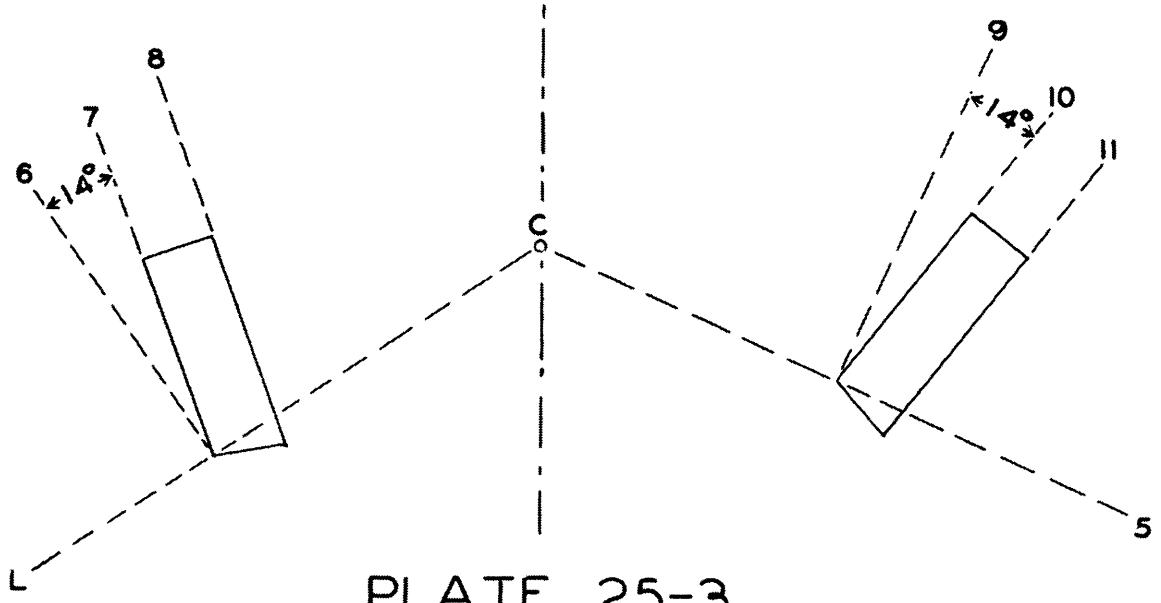

PLATE 25-3

SEC. 438—Form of Pallet Steels

The form of the pallet steels is to a large extent a matter of taste. Lightness of structure, however, is to be aimed at. Another condition that plays an important part is to have the arms of the pallets as near the wheel as possible in order that they may act, to some extent, as a counterpoise to the fork. The lower part of the fork only is represented in this drawing. It should be borne in mind that the fork as shown is at half its arc of vibration to the left of the line of centers; therefore, from the pallet center **C,** draw the line **12** at an angle of 4½ degrees from the line of centers. Draw two lines **13** and **14,** 6 mm at each side of and parallel with **12.**

The amount of steel surrounding the stones may be about 7 mm. The position of the lines forming the steels does not call for letting, but the means of locating them will be described. The arms being formed of arcs of circles, their centers must be located. For this purpose four centers, **JJ - MM - LL - KK** are found.

Locate center **JJ** 9.5 mm to the left of and 5.2 mm below the center **B.** Locate center **MM** 4.4 mm to the right of center **B.** Locate center **LL** 17.3 mm to the right of the center **B.** Locate center **KK** 29.2 mm to the right ofand 2 mm below the center **B.**

Arcs of 111 mm radius are drawn from **JJ** and **KK** to form the belly of the pallets. Arcs of 123 mm from **LL** and **MM** form the back of the pallet.

To form the circles that connect the pallets with the fork, two arcs of circles are drawn, each with a radius of 22 mm, from centers **NN** and **OO** and tangent to line **13** and arc **MM** and line **14** and arc **LL.** This completes the pallets.

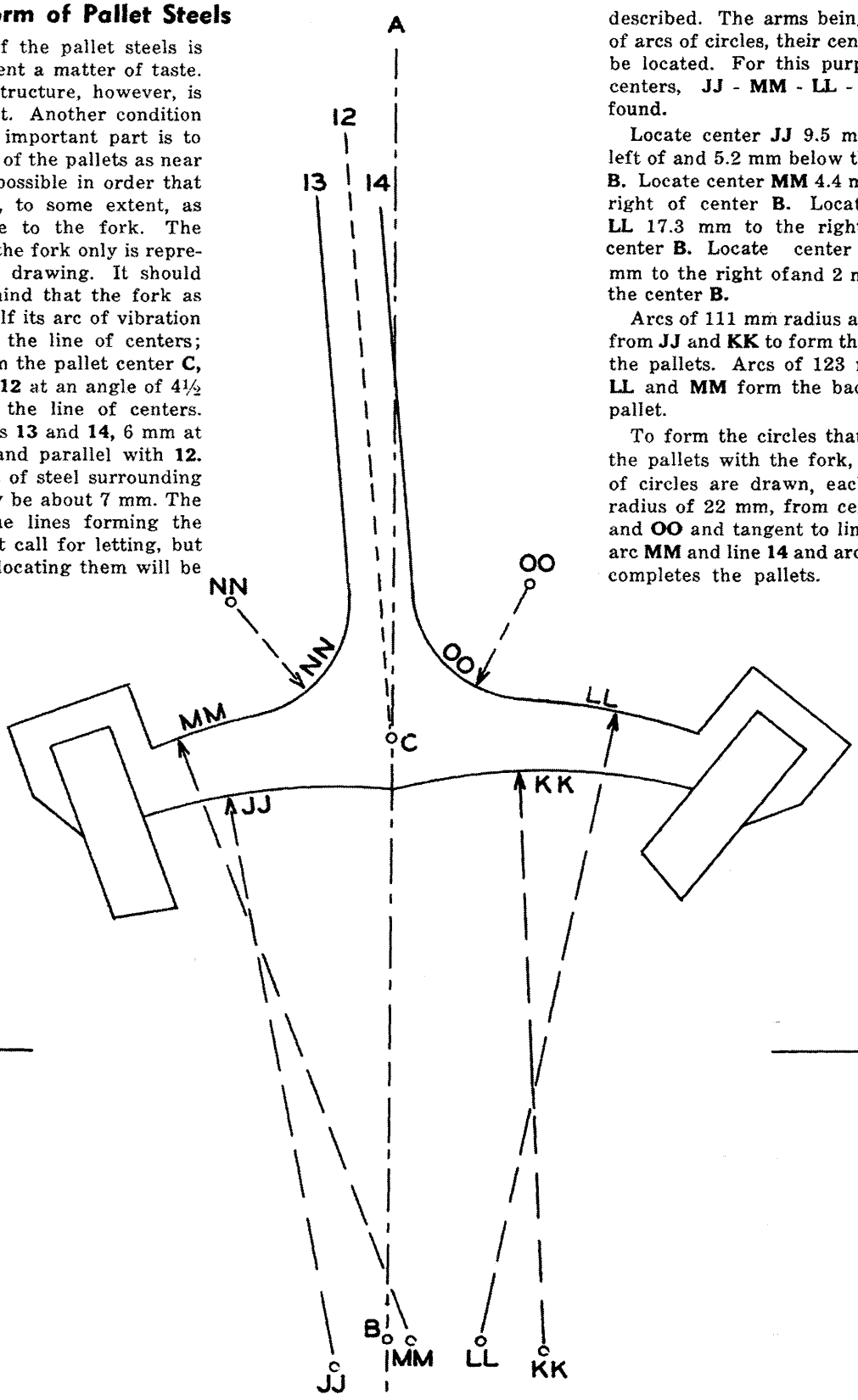

PLATE 25-4

SEC. 439—Laying Out the Fork and Roller

We will now proceed to lay out the fork and roller. Locate center **D**—170 mm above center **C** on line **A.** This will be the center of the balance and of the impulse and safety roller. With **C** as a center, extend line **12** at the left of center line **A.** The first point to be decided is the proportional distance of the roller jewel. On this will depend what is usually termed the freedom of the escapement. The proportional distances of the roller jewel and the fork slot from the centers upon which they vibrate is a highly important matter for consideration. The farther the roller jewel is from the center of the balance, the greater the force delivered by the fork, and the shorter the arc of contact; but as the force delivered by the fork to the roller jewel is increased by decreasing the length of the fork, the force delivered by the roller jewel in unlocking is decreased.

When a balance is stopped with the roller jewel on the line of centers and then released carefully, the watch should start even when the power is light—at the end of a 24 hour run. When a watch does not start under these conditions, it is said to "set on the impulse." A watch which is wound to the top but will not start when the balance is drawn to a position with the wheel tooth on the locking face, almost ready to unlock, is said to "set on the locking." This condition will be found when the fork is too short in proportion to the roller. An escapement that is free from these conditions is said to be a "free escapement." To avoid one or the other of these conditions it is necessary to have the distances properly proportioned to each other.

We will make them **3** to **1**; **3** for the fork, **1** for the roller jewel. With the dividers set at 42.5 mm, draw the arc of the circle **15** from **D** as a center. From **D** through the intersection of line **12** and arc **15,** which is the center of the roller jewel, draw line **16.** For the size of the roller jewel divide the total center distance 285 mm by **21,** which will give 13.6 mm. This is the diameter of the roller jewel. Setting the dividers at 7 mm, draw the circle **17** from the intersection of line **16** and arc **15.** This will be the roller jewel. The face of the roller jewel should now be drawn as follows: With the dividers set at 44.5 mm from center **D** draw the arc **18.** This arc will give the face of the roller jewel. Theoretically, the face of the roller jewel should be the arc of this circle instead of being flat, as is often seen. Draw the lines **19** and **20** parallel to **12** and tangent to circle **17.** These will give the sides of the fork slot. For the bottom of the fork slot draw the line **21,** 10 mm from the center of the roller jewel and at right angles to lines **19** and **20.**

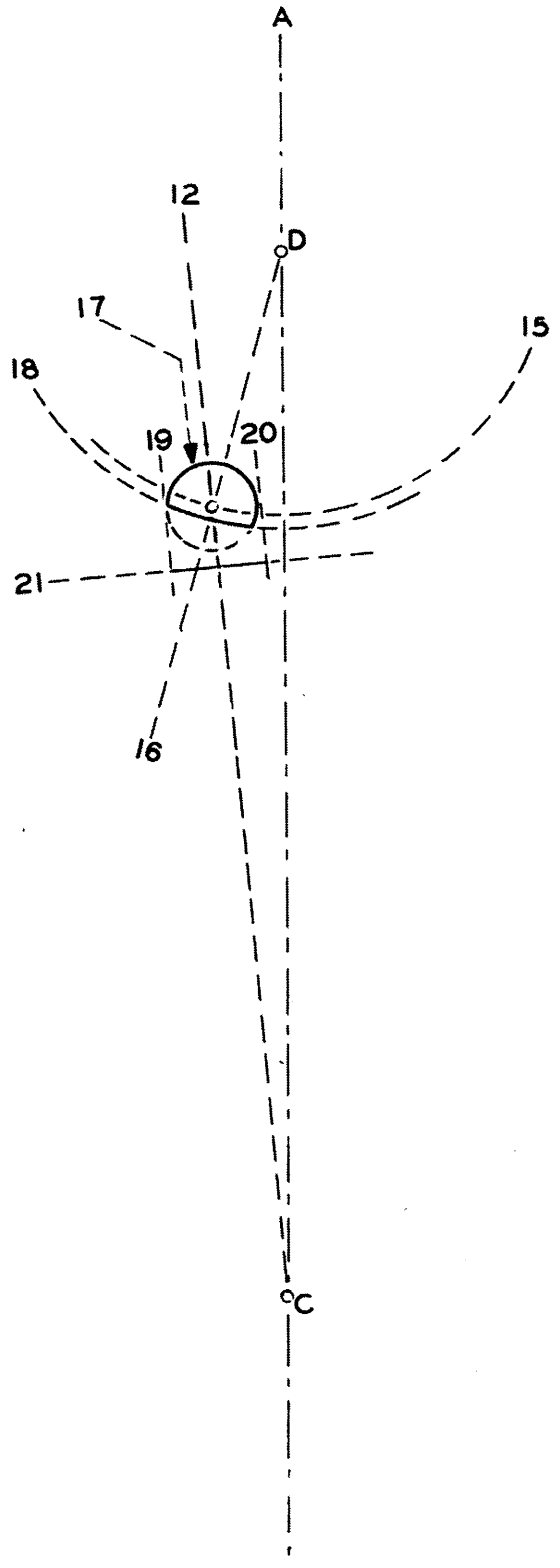

PLATE 25-5

SEC. 440—Fork Horns

The fork horns should extend at each side of the slot to a distance at least equalling its width. Setting the dividers at 22.5 mm, draw two short arcs, **22** and **23,** from the intersection of line **12** with arc **18.** The inside curves of the fork horn will end at these arcs.

The curves of the fork horns should be arcs of circles of the same radius, but not from the same center. In the position in which the fork is shown, the arc which forms the left horn is drawn from the roller center **D** and corresponds with arc **18.** To find the center for the curve of the right horn draw arc **24** from **C** as a center and through **D.** On this arc, to the left of its intersection with **12,** mark point **LL** at a distance equal to that from the intersection to **D.** From **LL** using the radius of arc **18,** draw an arc from Line **20** to arc **23.** This will be the right fork horn. From **LL** using the radius of arc **15,** draw arc **15A,** which will be used to locate center **MM** on plate 25-7.

The radius of the safety roller is usually two-thirds the distance from the roller center to the roller jewel center. With the dividers set at 28 mm, draw the circle **25.** This will be the safety roller.

The passing hollow may be of generous dimensions for the reason that the fork horns when made as directed provide additional safety against the fork going out of action. With the dividers set at 10.5 mm, draw arc **26** from a center at the intersection of line **16** with circle **25.** This will be the passing hollow.

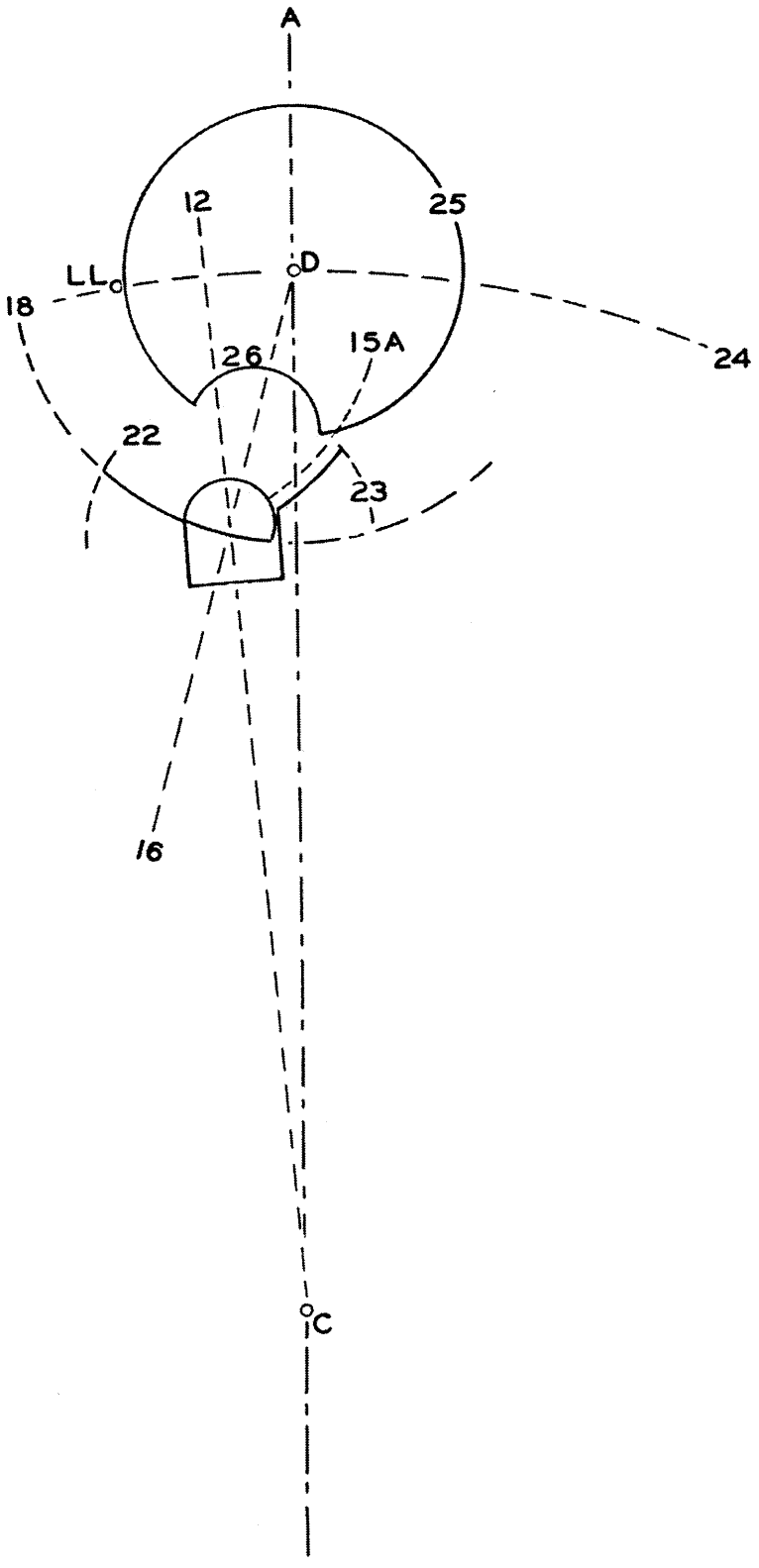

PLATE 25-6

SEC. 441—Guard Pin

The guard pin—sometimes called the dart—should be drawn with its point at the intersection of line **12** with circle 25. From this point draw lines **27** at each side of and 25 degrees from the line **12.** These will form the point of the guard pin. At each side of and parallel to the line **12** draw the lines **28.** These lines may be half the diameter of the roller jewel apart. They will form the sides of the guard pin.

The form of the fork is largely a matter of taste, lightness being a desirable feature.

Setting the dividers at 15 mm, mark the point **MM** on the arc **15** from center of roller jewel. Mark a similar point **MM** on arc **15A** to the right. From these points, with the dividers set at 7 mm, draw arcs of circles to form the ends of the horns as shown. These arcs are not lettered, but the student will have no difficulty in distinguishing them. From **C,** with the dividers set at 125 mm, draw the arc **29.** From the intersection of this arc with **12,** with the dividers set at 41 mm, mark the points **NN.** These points are the centers from which to draw arcs tangent to those forming the ends of the horns, thus forming the sides. With dividers set at 121 mm, from **C** locate center on line **12.** Draw arc from this center from sides of the horn to sides of fork (lines **13** & **14**). This completes the fork.

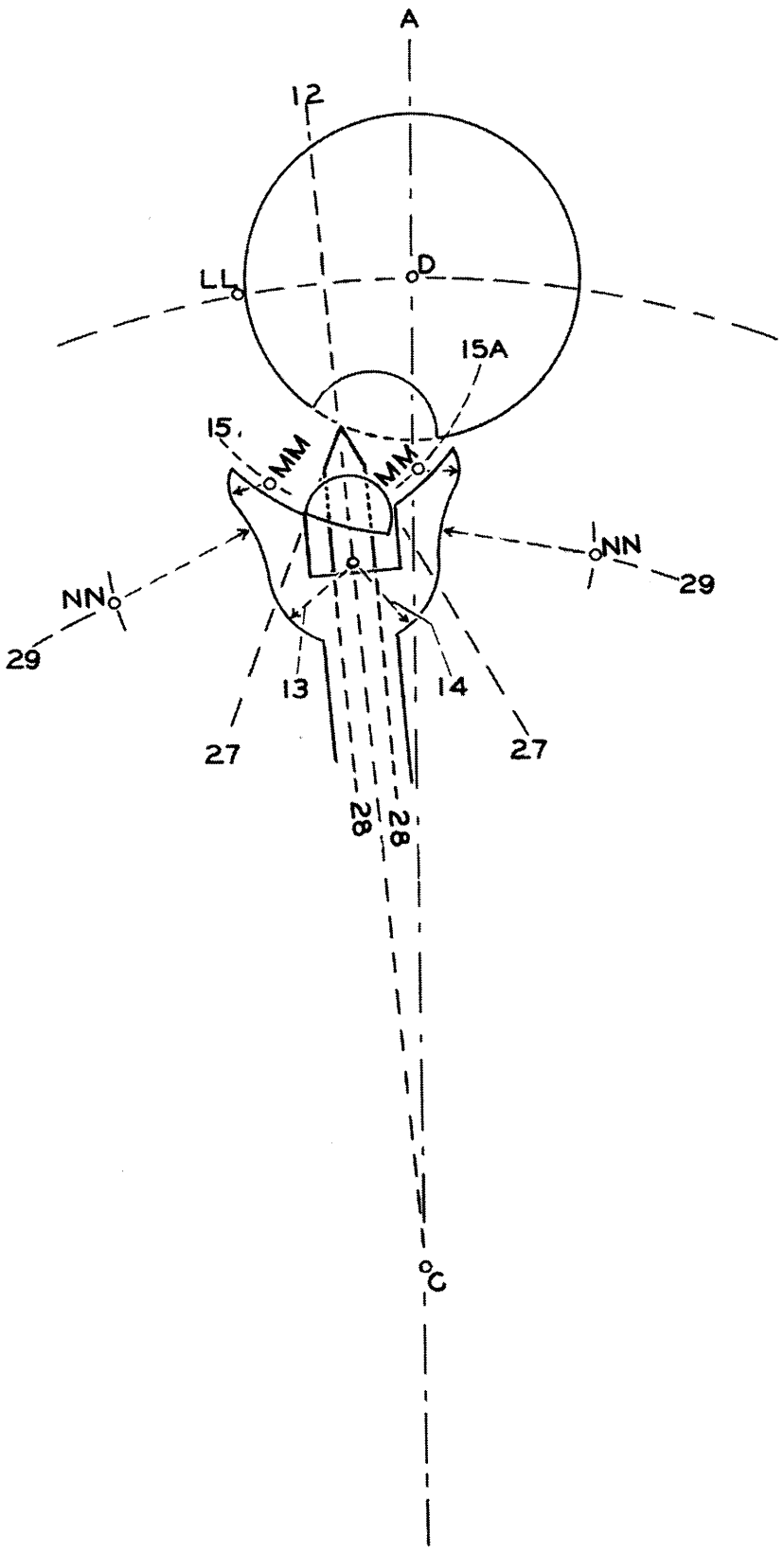

PLATE 25-7

SEC. 442—Banking Pins

The location of the banking pins, so far as their distance from the pallet center is concerned, is a matter of no vital importance. The best position would be the points which would arrest the fork by contacting it at its center of percussion. It is rarely, however, that circumstances will permit this. We shall locate them in about the usual place. With the dividers set at 95 mm, from **C** draw the arc **30.** Set the dividers at 20 mm, and mark the points **00** from the intersection of the arc **30** with the line of centers **A.** These will be the centers of the bankings. In drawing the bankings, it should be borne in mind that the pallets as shown are at the locking point, the slide not having taken place; consequently, the fork should not be represented in contact with a banking; therefore, draw them as shown leaving a space between.

The piece which carried the impulse roller jewel pin is generally made in the form of a disc and is called the impulse roller. Setting the dividers at 52 mm from the center **D,** draw the circle **31** to form the impulse roller. This will complete the entire escapement.

If the student has used a sharp, hard pencil for the working lines and drawn them lightly, they may now be erased. In case it is desired to keep the drawing for use as a reference, the working lines may be drawn in red.

Plate 25-9 shows the escapement divested of the working lines. Coloring the drawing will greatly improve the appearance. For this purpose colored pencils or crayons are most suitable. Color the pallet stones and roller jewel red. Color the roller tables blue, using two shades—light blue for the impulse roller and a little darker blue for the safety roller. Color the banking pins and escape wheel yellow. This completes the drawing.

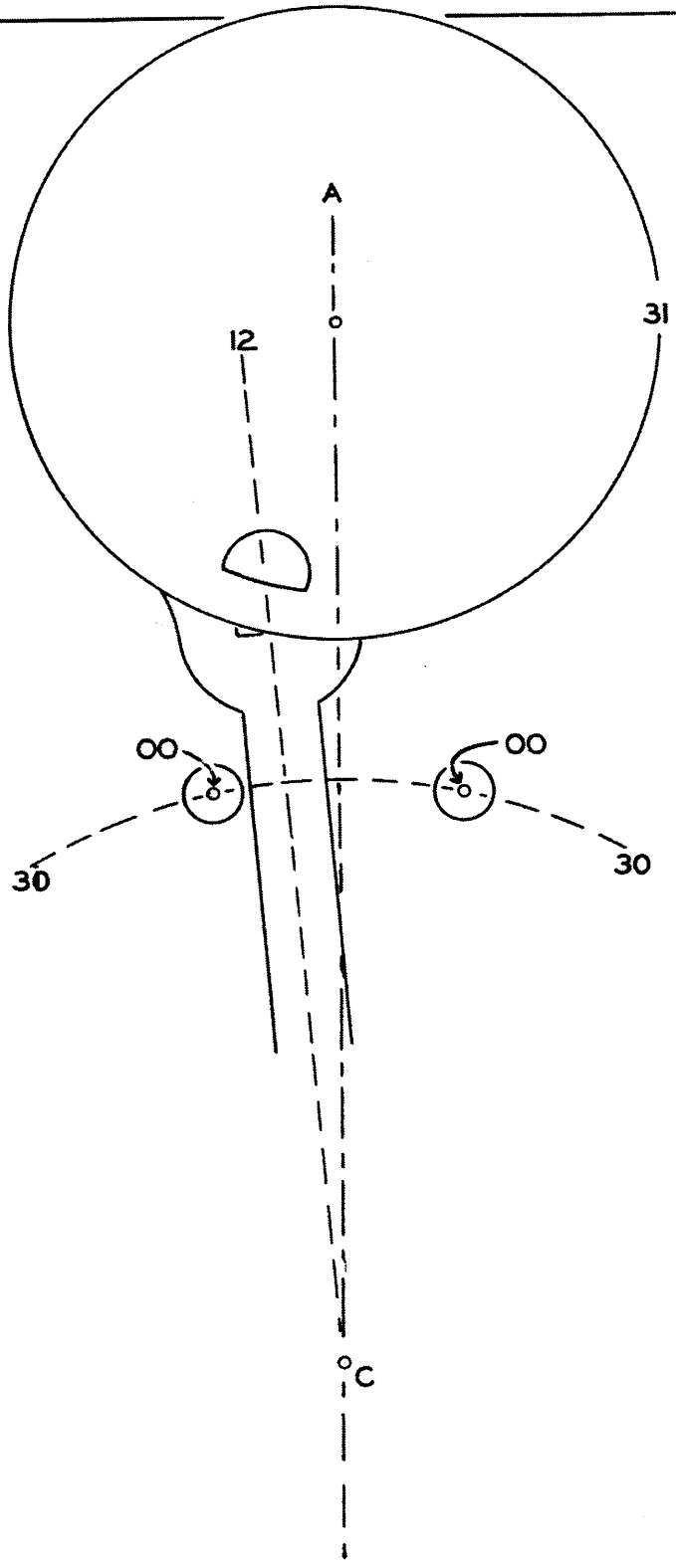

PLATE 25-8

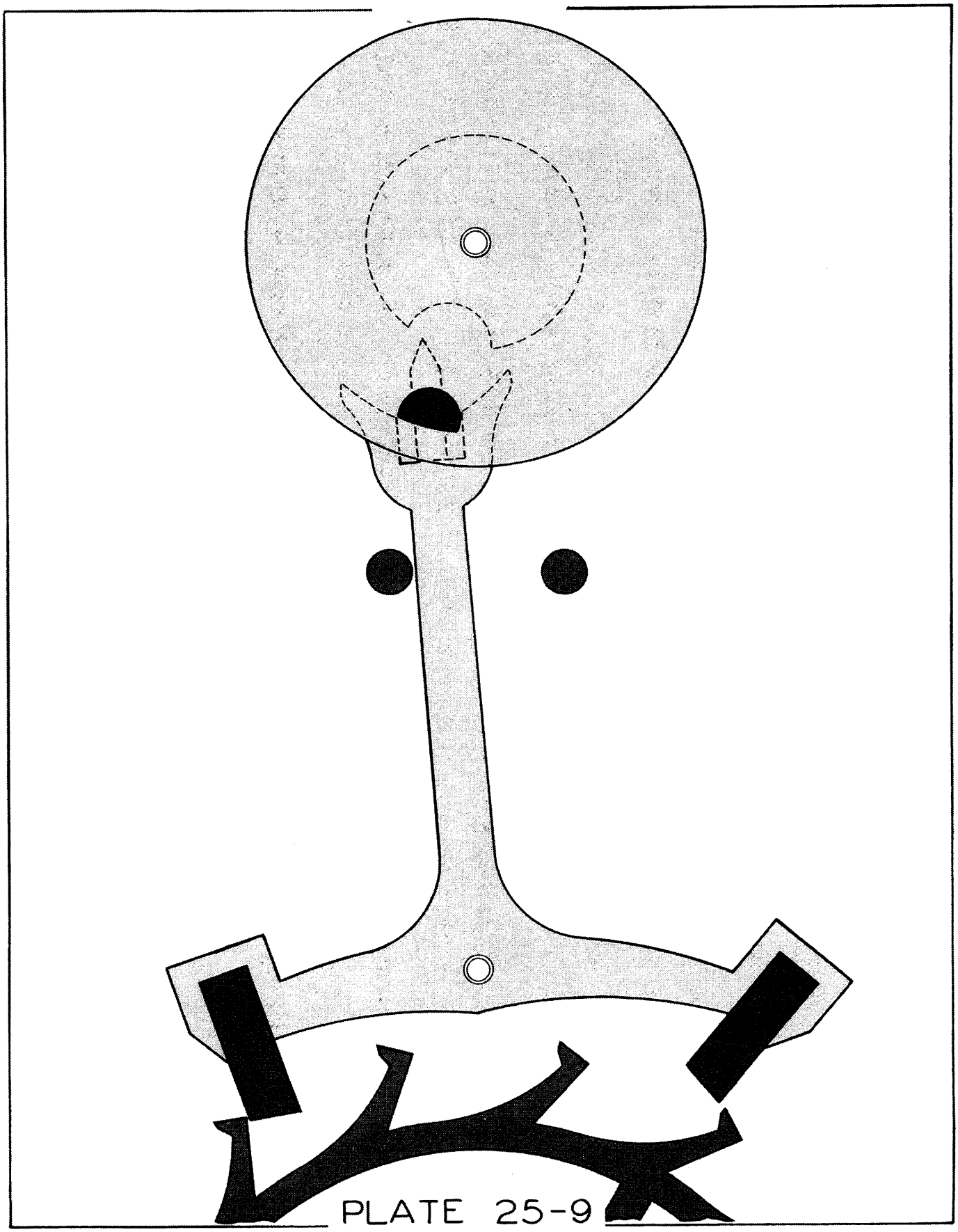

PLATE 25-9